

UK Patent Application

(19) GB (11) 2 254 280 (13) A

(43) Date of A publication 07.10.1992

(21) Application No 9107118.3	(51) INT CL ⁵ B23H 11/00
(22) Date of filing 05.04.1991	(52) UK CL (Edition K) B3V VEX V101
(71) Applicant Rolls-Royce plc (Incorporated in the United Kingdom) 65 Buckingham Gate, London, SW1E 6AT, United Kingdom	(56) Documents cited GB 2235893 A
(72) Inventor Keith Charles Moloney	(58) Field of search UK CL (Edition K) B3V INT CL ⁵ B23H
(74) Agent and/or Address for Service T C Jennings & V J Bird P O Box 31, Rolls-Royce plc, Patents Department, Derby, DE2 8BJ, United Kingdom	

(54) Electrodischarge drilling

(57) Drilling a hole through a wall of a hollow component into a cavity within the component by electro discharge machining so as to protect a far wall of the cavity from the electro discharge is carried out by injecting a molten non-electrically conductive wax into the cavity, permitting it to solidify, and carrying out the drilling until a change in the acoustic emission of the electrode as it enters the wax is detected. The drilling is then stopped, the electrode withdrawn, and the wax removed by steam.

GB 2 254 280 A

DRILLING HOLES IN COMPONENTS

This invention relates generally to drilling holes in components, and in particular to drilling a hole through a wall of a component into a cavity within the component by means of electro discharge machining, without damaging a far wall of the cavity.

Modern developments in gas turbine engines for use in aircraft require the generation of a high temperature gas stream within the engine, which in turn requires the use of special techniques to keep components, such as blades, that are in contact with the hot gas stream, at a temperature below that of the gas stream.

One of these techniques is to provide the component, which for convenience but without limitation we shall herein exemplify as a turbine blade, with a hollow interior or cavity, a series of small bore cooling holes passing from the cavity to the outer surface of the blade, and a continuous supply of cool pressurized air within the cavity, whereby in use cool air is forced out through the cooling holes over the outer surface of the blade and thereby protect the blade from the high temperature of the hot gas stream.

The cooling holes are of small diameter and, to fulfil their purpose, must be very accurately located, machined and drilled. One way of providing cooling holes having such requirements is by the known technique of electro discharge machining, which we shall hereinafter refer to as "EDM".

A problem arising out of the use of EDM to drill holes into a cavity in a blade is that of the EDM electrode impinging on the far wall of the cavity being drilled

into, with possible consequent damage not only to the electrode but to the far wall of the cavity. Damage to the wall of the cavity may have a deleterious effect on the air flow through the cavity and may possibly weaken the structure of the blade.

Hitherto, attempts to deal with the problem of far wall impingement have been by detecting breakthrough of the EDM electrode by electrical means, or by insertion of a metallic impingement guard into the cavity. Both these methods are inconvenient in that they either require the use and control of relatively expensive electrical detection apparatus, or the provision of purpose-made metallic inserts. Metallic inserts are not always possible if the cavity is of an awkward shape, and there remains the danger that the EDM electrode may be damaged by contact with the insert.

According to the present invention there is provided a method of drilling a hole through a wall of a component into a cavity within the component by means of electro discharge machining, the method comprising the steps of, (a) injecting a molten non-conductive material into the cavity so as to fill the cavity, (b) permitting the material to solidify within the cavity to a relatively soft consistency, (c) drilling a hole through a wall of the component into the cavity by means of an electro discharge electrode, (d) detecting breakthrough of the electrode into the material within the cavity, (e) withdrawing the electrode from the component, and (f) removing the material from the cavity.

Preferably, the material is a wax, and may be removed from the cavity by steam cleaning.

The breakthrough of the electrode into the cavity may be

detected by observing a change in the acoustic properties of the electro discharge as the electrode contacts the material within the cavity on breakthrough.

In an example, the cavity in a hollow gas turbine blade was injected and filled with a molten wax which was then allowed to solidify. A hole was drilled into the cavity through the wall of the blade by means of an electro discharge machine electrode. Breakthrough of the electrode into the cavity was observed by an audible change in the sparking noise of the electrode as it contacted the solidified wax within the cavity.

Drilling was then stopped and the electrode withdrawn from the blade. The wax was then removed from the cavity by the application of steam which steamed out the wax.

Inspection revealed that there had been no impingement of the electrode on the back wall of the cavity, and no damage to said back wall.

The wax was seen to have served four purposes:

- (1) It protects the back wall of the cavity from the electro discharge machining because it is non-conductive.
- (2) It allows the electrode to continue some way into the cavity and to widen the exit point of the hole into the cavity, and slows down the rate of travel of the electrode, thus enabling breakthrough to be detected more easily.
- (3) It does not damage or bend the EDM electrode.

(4) It produces an audible difference on breakthrough as it absorbs the "sparking noise" of the EDM electrode.

A material other than a wax may be used provided it is non-conductive or aprotic, solidifies when applied, and is easily removed by the application of heat or a hot solvent.

The method of the invention may be applied to the drilling of holes into cavities of components other than hollow turbine blades.

CLAIMS

1. A method of drilling a hole through a wall of a component into a cavity within the component by means of electro discharge machining, the method comprising the steps of, (a) injecting a molten non-conductive material into the cavity so as to fill the cavity, (b) permitting the material to solidify within the cavity to a relatively soft consistency, (c) drilling a hole through a wall of the component into the cavity by means of an electro discharge electrode, (d) detecting breakthrough of the electrode into the material within the cavity, (e) withdrawing the electrode from the component, and (f) removing the material from the cavity.
2. A method as claimed in claim 1 wherein the material is a wax.
3. A method as claimed in claim 2 wherein the wax is removed from the cavity by steam cleaning.
4. A method as claimed in any preceding claim comprising detecting breakthrough of the electrode into the cavity by observing a change in the acoustic properties of the electro discharge as the electrode contacts the material within the cavity on breakthrough.
5. A method of drilling a hole through a wall of a component into a cavity within the component substantially as herein described with reference to the example.

Relevant Technical fields

(i) UK CI (Edition K) B3V

Search Examiner

D N P Butters

(ii) Int CI (Edition 5) B23H

Databases (see over)

(i) UK Patent Office

Date of Search

23 May 1991

(ii)

Documents considered relevant following a search in respect of claims

ALL

Category (see over)	Identity of document and relevant passages	Relevant to claim(s)
X	GB 2235893 A (ROLLS ROYCE)	1, 2, 3

SF2(p)

3TPABF

Category	Identity of document and relevant passages	Relevant to claim(s)

Categories of documents

X: Document indicating lack of novelty or of inventive step.

Y: Document indicating lack of inventive step if combined with one or more other documents of the same category.

A: Document indicating technological background and/or state of the art.

P: Document published on or after the declared priority date but before the filing date of the present application.

E: Patent document published on or after, but with priority date earlier than, the filing date of the present application.

&: Member of the same patent family, corresponding document.

Databases: The UK Patent Office database comprises classified collections of GB, EP, WO and US patent specifications as outlined periodically in the Official Journal (Patents). The on-line databases considered for search are also listed periodically in the Official Journal (Patents).